Developing the Capacities of Arab Countries for Climate Change Adaptation Using Integrated Water Resources Management Tools
Developing the Capacities of Arab Countries for Climate Change Adaptation by Using Integrated Water Resources Management Tools
Arid and semi-arid areas – such as those found across the Arab region – are exposed to the impacts of climate change on water resources, through increased variability in precipitation and seasonal runoffs, shifts in water supply, water pollution, reduced water quality, groundwater salinization among many other reasons. Certain consequences of climate change have irreversible long-term impacts, yet these impacts vary in time and space, ranging between daily/local scales and longer/larger scales. Current water management practices are not sufficiently robust to cope with the future impacts of climate change on water resources, with illegal activities likely to further exacerbate such impacts. As a result, sustainable development, economic growth, poverty reduction, food security, and the health of people and ecosystems are at risk, especially in less developed countries or countries facing conflict or unrest.

In response, the Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR) was launched as a collaborative effort by the United Nations and the League of Arab States through a cooperation involving 11 regional and international partner organizations. Several ensembles of climate projections were generated for the Arab region within RICCAR, assessing climate change impacts such as change in temperature, precipitation, surface runoff, hydrological parameters and extreme climate indices. These projections and outputs were then utilized as inputs for a vulnerability assessment to identify hotspots vulnerable to climate change in the Arab region using integrated mapping tools.

The United Nations Development Account (UNDA) Project on Developing the Capacities of the Arab Countries for Climate Change Adaptation builds upon the work conducted under RICCAR to strengthen the regional capacity for climate change adaptation, drawing upon assessment tools and regional experience in climate change assessment and adaptation. This manual seeks to assist Arab countries in developing their adaptive capacity by applying Integrated Water Resources Management (IWRM) tools in five strategic sectors, namely agriculture, environment, health, human settlements and economic development. The project was led by the United Nations Economic and Social Commission for Western Asia (ESCWA) in collaboration with the following organisations, each of which led the preparation of a module:
• **Environment module**: United Nations Environment Programme (UN Environment);
• **Agriculture module**: Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD) and Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ);
• **Health module**: World Health Organization, Centre for Environmental Health Activities (WHO/CEHA);
• **Human settlements module**: Arab Countries Water Utilities Association (ACWUA);
• **Economic development module**: Economic and Social Commission for Western Asia (ESCWA).

Integrated Water Resources Management

The integrated water resources management (IWRM) collectively considers cross-cutting goals and ensures that water management decisions address the impact of each sectoral use on other sectors. IWRM, thus, cannot be partially implemented and should concern all the functions of water resources management such as water allocation, pollution control, monitoring, financial management, flood and drought management, information management, basin planning and stakeholder participation.

IWRM is based on three key concepts and principles, namely that freshwater is critical to sustaining life, that water is both an economic and social good, and that everyone is a stakeholder in matters of water resources. IWRM implementation is defined by two systems: the biophysical system – for example, water basins and climate – and the socio-economic system.

Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region

A stepwise approach was followed in the integrated assessment pursued under RICCAR. The impact assessment component is based on the generation of dynamically downscaled regional climate models (RCM) covering the Arab domain, nested in a series of general circulation models (GCM). These outputs are used to run regional hydrological models (RHM) as well as basin-level hydrological models. The outputs of these models are then used to inform the regional vulnerability assessment based on an integrated mapping approach.
The resulting integrated assessment links the climate change impact assessment to a socio-economic and environmental vulnerability assessment.

The vulnerability assessment component in RICCAR is based on the methodology of the Intergovernmental Panel on Climate Change (IPCC). Within this perspective, vulnerability is understood to be a function of a system’s climate change exposure, sensitivity and adaptive capacity to cope with climate change effects.

Mainstreaming gender into climate change projects

As information forms a key element to establish legal, economic or outreach instruments for managing ecosystems, gender-disaggregated data at national and local levels and within monitoring systems is essential for designing policies and setting programmes to take gender issues into consideration so as to increase women’s participation in enhancing ecosystems and preventing their decline.

With women often comprising a significant proportion of agricultural workforce, such as in Egypt (23% of the total sector and 58% of total female rural workers), gender aspects of climate change need to be integrated into adaptation measures, to ensure that women are not malnourished or, at a more structural level, to ensure that their low rates of land tenure are reversed.

Women are often a source and a transmitter of knowledge and skills related to health and nutrition, including how to cope with harsh conditions such as high temperatures and drought, and are typically the first “line of defence” when it comes to children’s personal hygiene and other factors that help prevent disease. Thus, special attention must be paid to training women, especially with regard to water scarcity and climate variability.

In many areas of the developing world, women in poor households disproportionately feel the impacts of climate change, be it droughts, extreme weather events, or loss of food production. Efforts should be made to ensure that female school enrolment levels do not suffer, and that women do not lose out on income-generating activities.
Projections are based on two representative concentration pathways (RCPs). RCP4.5 is the moderate case scenario and RCP8.5 is the worst case scenario currently being modelled. Climate modelling outputs in RICCAR were generated at a 50 km x 50 km scale. Findings on extreme climate indices for the Arab region were also generated. The change in extreme temperature indices include the cold spell duration index, summer days with a maximum temperature exceeding 35°C or 40°C and tropical nights. The projected extreme precipitation indices generated include the maximum length of dry spell, heavy precipitation days (≥ 10 mm), very heavy precipitation days (≥ 20 mm), and other indices.

Who should use this manual?

Water resource availability affects numerous sectors, and various governmental institutions deal with policymaking, planning and implementation related to water resources management. This training manual thus benefits a wide range of officials from the public sector, academia, non-governmental organisations and the private sector. The manual also benefits those interested in learning about the different aspects of climate change impacts on water resources, the associated linkages to five sectors targeted in this manual and the use of IWRM as a tool for climate change adaptation in these sectors. The following groups should find this manual of particular interest:

- Decision-makers and technical staff in the water sector and the other five sectors, who are concerned with the sectoral dimensions of climate change and with developing and implementing policies, programmes or projects;
- Decision-makers and technical staff in other government sectors, who are concerned with water and the multi-sectoral dimensions of climate change (such as spatial planning, environment, agriculture, food, disaster risk reduction, transport, industry, labour, education, etc.);
- Stakeholders involved in the development and implementation of national adaptation plans, national adaptation programmes of action, nationally appropriate mitigation actions and national communications;
- Representatives involved in the global United Nations Framework Convention on Climate Change (UNFCCC) process, such as negotiators and UNFCCC focal points;
- General multi-sectoral and water sector staff and other professionals providing water and relevant services;
- Women and other vulnerable population groups;
- Civil society and, to a lesser extent, local community representatives;
- Non-governmental organization experts, who are active in the area of climate change and/or water and the five concerned sectors;
- Academics, scientists and researchers working on climate change adaptation in the water sector and the other five sectors.

The manual presents these issues within a regional context based on the practical experiences of practitioners working in the Arab region, who are concerned about the impact of climate change on water resources and how climate change adaptation can be pursued across five key sectors.
Climate Change Adaptation and Ecosystem-Based Management Using Integrated Water Resources Management Tools

Environment
Climate change impacts on the environment from a water perspective

Ecosystems in the Arab region bear universal significance as the region is the source of genetic species that contribute to over 70 per cent of food crops that are globally consumed today, and boasts varying endemic species of global importance (UNEP, 2015). Significant impacts on the environment are being felt due to changes in temperature, dry spells, precipitation and extreme winds, where, for example, some projections suggest up to 20 per cent reduced rainfall that, coupled with higher temperatures, would decrease the Euphrates and Jordan rivers’ waterflows, thus affecting agriculture. Other systems at risk include the coastal mountain ranges of the Red Sea, the cedar forests in Lebanon and the Syrian Arab Republic, mangroves along certain coastal areas of the Arabian Peninsula, reed marshes in Iraq, the mountain ranges in Oman and Yemen and all the major river systems (AFED, 2009). Among the impacts already felt are invasive species, with 551 of such species already present in the Arab region; climate change is expected to exacerbate the situation (UNEP, 2010).

Dry spells are likely to impact forest areas in the West Asia region, where recent analysis indicates that forest loss has increased over the recent decade leading to a precarious situation, as forest cover already represents less than 1 per cent of land cover. At the same time, changing precipitation is expected to result in a decline of discharge in the Euphrates and Tigris rivers by the end of this century, by 30 per cent and 50 per cent, respectively (UNEP, 2010; AFED, 2009).

As the loss of around 90 per cent of Iraq’s marshlands is considerably impacting human life and ecosystems, the Regional Office for West Asia of the United Nations Environment Programme embarked on a project to support the nomination of the Iraqi marshlands as a World Heritage Site. A management planning exercise, integrating the cultural and natural components of the World Heritage Site, was undertaken in close consultation with marshland stakeholders, relevant local authorities and ministries. It takes threats from extreme drought, climate change, mining, water dams and sand and dust storms into consideration. It was developed in collaboration with the International Union for Conservation of Nature/Regional Office for West Asia, the Arab Regional Center for World Heritage, UNESCO, the Ministry of Environment and the Ministry of Tourism and Antiquities.

Nine lakes in North Africa are extremely vulnerable to wind variability and dry spells, imperilling key bird habitats, while it is projected that all 109 Ramsar sites in the Arab region will be affected by the impacts of climate change (Ramsar, 2007).
RICCAR outputs support the impact and vulnerability assessment of the environment sector

The RICCAR output for the environment sector is the aggregation of overall vulnerability of both the forests and wetlands subsectors. Although both subsectors equally contribute to the sector vulnerability assessment, the forests subsector has a stronger correlation. The result generally indicates a low to high gradient from north to south, with areas of high vulnerability in the Horn of Africa.

Most of the Arab region has only a slight increase in vulnerability from mid- to end-century under both moderate and extreme case scenarios, although improvements in reforestation/afforestation efforts are expected to increase biodiversity and ecosystems in the region as a whole. Up to 3 per cent of identified biodiversity areas are classified as hotspots, including forests in the southern Sarawat Mountains, northern Horn of Africa, the southeastern Sahel, and the Blue Nile river (RICCAR, 2017).

IWRM tools and ecosystem-based management approach for identification of adaptation measures and options

Global experiences reveal that successful IWRM implementation is limited in achieving its potential due to inadequate resourcing and fractured governance structures that continue to manage ecosystem services as distinct, department- or sector-specific objectives. Actively pursuing an agenda of ecosystem services would help integrate these sectoral goals through watershed management, while economic instruments, such as payment for ecosystem services, would help provide incentives and resources for such initiatives. Thus, both limitations could be potentially overcome by moving from a more traditional form of IWRM to one that incorporates ecosystem management principles, encourages incentives and markets for managing and providing healthy and sustainable ecosystem services, and addresses drivers of ecosystem change in a more systematic fashion.

Implementation of adaptation measures

The driving force-pressure-state-impact-response (DPSIR) framework analyses the dynamic interaction of human society and the environment, whereby the state of the environment is a combined result of broad natural and anthropogenic forces of change or pressures (Pintér and others, 2008). Given significant differences among ecosystems based on location, size, socio-economics and other factors, issues tend to
Differ from one place to another and over time, making periodic review essential. Indicators are an effective means to measure issues and diagnose problems or measure the effects of management actions.

Combining ecosystem-based management (EBM) and IWRM tools provides an effective preparedness to adapt watersheds and associated human communities to climate change impacts in the Arab region. Practically, there are twelve principles for the implementation of ecosystem-based watershed management covering societal choice, decentralization, spillover effects, economic context, conservation, functional limits, spatial and temporal scales, long-term outlooks, inevitability of change, appropriate balances, relevant information, and relevant sectors.

**Areas for action: Suggestions for follow-up**

Stakeholders responsible for water and ecosystem resources are encouraged to consider a variety of EBM and IWRM tools, some of which might require national-level policies while others could be more effective through a bottom-up approach. These include resource and tax incentives, although incentives may be limited to the short term, or natural resource accounting, which ultimately helps to manage expectations and to strengthen measurement and monitoring capacities.

### Linkages among principles, structures and targets

<table>
<thead>
<tr>
<th>Principles</th>
<th>Structures</th>
<th>Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic efficiency</td>
<td>Management instruments</td>
<td>Framework for provision of water ecosystem services</td>
</tr>
<tr>
<td></td>
<td>Enabling environment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Institutional framework</td>
<td></td>
</tr>
<tr>
<td>Equity</td>
<td>Policies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Legislation</td>
<td></td>
</tr>
<tr>
<td>Environmental sustainability</td>
<td>Central-Local</td>
<td></td>
</tr>
<tr>
<td></td>
<td>River basin</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Public-Private</td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Adapted from UNEP-IISD-DHI, 2011, p.17.
Climate Change Adaptation in Agriculture, Forestry and Fisheries Using Integrated Water Resources Management Tools
Climate change impacts on agriculture from a water perspective

The adverse pressures felt by agriculture, forestry and fisheries in the Arab region due to natural and socio-economic constraints are exacerbated by climate change. Impacts range from limited water resources that are further hampered by non-adapted lifestyles of urban elites or by pollution reducing water usability (Cap-Net, 2005), to shrinking land resources as only 35 per cent of land is estimated to be suitable for agricultural production (Mansour and others, 2011). Governance, legislation and administration are also areas of concern, particularly the insufficient levels of governmental commitment to rural areas, fragmented responsibilities, limited land tenure rights for women, and the lack of economic incentives to apply water conservation methods.

Rising water demand is a great concern with nearly 75 per cent of water resources allocated to agriculture, 22 per cent to domestic use, and 3 per cent to industry (FAO, 2012), while groundwater and surface water supplies are dwindling.

Impacts of climate change are evident across subsectors. In rainfed agriculture, farmers hardly invest in soil conservation measures, and low yield levels prevent any increase in food self-sufficiency. As for irrigated agriculture, available funds often address irrigation methods rather than crop needs or water scarcity. Animal husbandry suffers from inadequate veterinary services, and camel breeding is not sufficiently promoted in spite of the ability of camels to cope with arid conditions and their protein richness. With more extreme heat spells increasing forest fires, deforestation is a cause for concern, along with over-grazing and the felling of trees for fuel. Fisheries are not gaining sufficient momentum due, in part, to limited cold storage and processing infrastructure and the absence of a value chain approach, which raises the particular concern of job creation for women.
RICCAR outputs support the impact and vulnerability assessment of the agriculture sector

Climate change threatens agricultural production through higher and more variable temperatures, changes in precipitation patterns and increased occurrences of extreme events, such as droughts and floods. Impacts include an increase in the demand for water, water logging and soil erosion; direct damage to plants; and rising salinity of groundwater (IPCC, 2014).

The RICCAR crop vulnerability maps show that most of the cropped areas in the Arab region lie within the highest three vulnerability classes, where evapotranspiration will increase and runoffs will decline, resulting in increased water scarcity. The “Climate Change and Adaptation Solutions for the Green Sectors of Selected Zones in the NENA Region” project led by GIZ, ACCWaM, FAO, ACSAD and ESCWA used the FAO AquaCrop model to project the impact of climate change on the dominant crops in selected zones: wheat, maize and cotton in Egypt, representing irrigated agriculture; rainfed wheat and barley in Jordan, representing very dry arid zones; and irrigated eggplant, maize and potato in Lebanon, representing mixed agricultural zones. Results show that the growing period will decrease by 10-30 days due to increases in temperature and that, in spite of projected increases in temperature, the crop water requirement is projected to decrease by 5-20 per cent. The simulation also shows that without inclusion of elevated carbon dioxide effects, climate change is projected to result in the decrease of crop yield.

Impacts of climate change can be broken down into three orders, of which RICCAR only distinguishes the first two: the first order is the direct effects of climate change due to the increase of greenhouse gases in the atmosphere; second-order impacts include changes in our ecosystems that are induced by the first order; and the third-order impacts are changes caused by the second order.

Exposure reflects the impact of the most relevant climate parameters; sensitivity looks at the parameters that determine the robustness or weakness of farming systems towards exposure to climate change impacts; and adaptive capacity has to be measured through institutional, socio-economic, financial and other parameters.

IWRM tools for identification of adaptation measures and options

IWRM provides a holistic approach that seeks to balance water demand with available water resources, improve allocation of water amongst competing uses, apply water conservation measures, protect water quality and improve cost management. The approach includes a range of tools and aspects that relate to implementation, including planning, conflict resolution and monitoring.
IWRM reflects the goal of adaptation measures, namely to improve water management to balance multiple uses of water resources and to realize economic, social and environmental benefits, with the last two benefits largely unaccounted for in economic policies despite the strong nexus between water, energy and food production (ESCWA, 2015).

When selecting adaptation measures, it may be useful to distinguish adaptation measures in two ways: the first distinguishes between autonomous (i.e. spontaneous) adaptation and planned adaptation (i.e. due to a decision), while the second distinguishes between reactive and anticipatory adaptation (Cap-Net, 2009). These distinctions are to be applied alongside location-specific criteria for the prioritization of adaptation measures.

Implementation of adaptation measures

The success of adaptation in agriculture depends on how different stakeholders play their roles, noting that there are many stakeholders dealing with various elements at the local, national, regional and global levels, all of which have water management as their core or partial activity.

The Arab region presents numerous examples of adaptation measures, such as groundwater recharge in Saudi Arabia through floodwaters, and fog collection in Morocco, Oman and Yemen. Water storage has been addressed in Lebanon by collecting rainwater from greenhouse rooftops, while in the slopes of the West Bank in the State of Palestine, water harvesting can prove to be an effective tool in the face of water scarcity. Aquaculture is practiced in numerous Arab countries with significant opportunities for increases in production, particularly in Egypt that accounted for 93 per cent of the region’s production in 2013.

Areas for action: Suggestions for follow-up

While adaptation should be locally driven, with strong participation by local communities, it should also be supported by national policies and frameworks. There should be a move from support for projects to support for national adaptation plans, development interventions, and the integration of adaptation measures into the design and implementation of development plans, poverty reduction strategies and sectoral policies and strategies (Osman-Elasha, 2006). With the estimate that women produce 60-80 per cent of food in most developing countries and are responsible for half of the world’s food production (FAO, 2005), more recognition should be paid to women’s contributions to the agricultural sector and to their widespread shouldering of the responsibilities of household and resource management (Osman-Elasha, 2007).
Climate Change Adaptation in the Health Sector Using Integrated Water Resources Management Tools
Climate change impacts on health from a water perspective

Addressing the impacts of climate change on human health is challenging because of the wide spectrum of determinants that influence health, including the physical and social environment, the introduction of new technologies, and changing political landscapes that reshape social and economic conditions. Direct impacts of climate change on human health include mortality and morbidity following extreme weather events (such as floods, heatwaves, droughts and hurricanes), while indirect impacts on human health include longer-term climatic changes that affect the range and reproductive rates of disease vectors, extending transmission seasons, increasing the incidence of foodborne and waterborne diseases, and resulting in poor air quality and food insecurity (IPCC, 2007; IPCC, 2014).

RICCAR outputs support the impact and vulnerability assessment of the health sector

Vulnerability and adaptation assessments improve the understanding of the linkages between climate change and health, and serve as a baseline analysis against which changes in disease risks and protective measures can be monitored.

Well-functioning institutions and access to quality healthcare safeguard individual and population health, while the society’s vulnerability is a function of exposure, sensitivity and adaptive capacity. The sensitivity of a society encompasses the ability to withstand exposures and impacts, as well as physiological and socio-economic factors that increase the susceptibility of individuals to exposure. The potential public health impact can be offset by adaptive capacity. Several methods exist to assess the vulnerability and sensitivity of a country to adapt to the impacts of climate change.

Intersectoral and cross-sectoral adaptation strategies are needed as many of the possible measures for adapting to climate change lie primarily outside the direct control of the health sector, namely in areas such as sanitation and water supply, education, agriculture, trade, tourism, transport, development and housing.

Source: Adapted from U.S. Climate resilience Toolkit https://toolkit.climate.gov/topics/human-health.
IWRM tools for identification of adaptation measures and options

Societies need to engage in a process to select different types of health-related adaptation measures that would then constitute a national action plan. In a sense, the types of measures follow a lifecycle of prevention, resilience, preparation, response and finally recovery. These types of adaptation measures are spread across five levels: first, promoting institutional and strategic interventions (such as intersectoral coordination and regional collaboration); second, addressing environmental quality monitoring and control; third, enhancing health institutions; fourth, promoting awareness raising and capacity development (by targeting vulnerable communities, such as rural women); and fifth, adopting early warning systems (such as disaster risk management).

Identifying the needed adaptation measures for the health sector can start by consulting stakeholders, as a basis for a review of all possible adaptation measures related to water availability, quality and health. Next is the evaluation and prioritization of all possible adaptation measures for their suitability and applicability to the study area under consideration, and last is the development of needed mechanisms and interventions to integrate the proposed health and water adaptation measures into national policies and action plans.

Implementation of adaptation measures

A number of different approaches can be used to assess the institutional and legislative contexts. They are critical for the implementation success of any adaptation plan on health. One such approach is governance description, which is essentially empirical in that it consists of describing the actors and institutions. Governance design is more prescriptive by considering how to design effective institutions assuming that the link between institutions and outcomes can be understood and predicted with some confidence. Deriving statistically significant results from studying variables of socio-ecological systems and outcomes is the basis of the governance emergence approach.

Nevertheless, there are barriers to the transfer of technologies and practices and their ability to reduce greenhouse gas emissions and climate change impacts (IPCC TAR, 2000). Thus, identifying and categorizing such barriers – for example policies and procedures; human and financial capital; institutional coordination and collaboration; and information and tools – becomes a key step in adopting appropriate adaptation measures.

Areas for action: Suggestions for follow-up

Countries should carry out a number of steps to develop an effective national adaptation plan, starting out with national and sub-national assessments covering climate change and health impacts while preferably using
standardized assessment methods and tools. This should be followed by the establishment of surveillance systems and monitoring processes that can detect variables and evidence of health-related climate change impacts and adaptation results. Adaptation strategies and policies are then developed, tempered by analysis of barriers and opportunities for enhancing adaptive capacity. Lastly, assessments must be focused not only on science but also on policy, such as evaluating risk management adaptation options or deciphering uncertainties in decision-making. The development of adaptation programmes at the national level should be complemented by regional and global policy interventions, including, for example, establishing regional task teams, creating expert networks, or instituting technical and financial assistance mechanisms.

Climate Change Adaptation in Human Settlements
Using Integrated Water Resources Management Tools
Climate change impacts on human settlements from a water perspective

The Arab region is classified as arid to semi-arid and is the poorest in freshwater resources worldwide, with almost 75 per cent of its population living under the water poverty level and nearly half under extreme water scarcity. Urbanization also poses significant challenges, with the proportion of those living in cities expected to rise from 56 per cent in 2010 to 68 per cent by 2050, representing a doubling in actual numbers during the same period, with most of the growth taking place in city peripheries (UN-Habitat, 2012).

Physical infrastructures are also a cause for concern, such as water distribution networks in several Arab countries that lack continuous flows of water, often resulting in inconsistent and higher pressure on fittings, thereby leading to additional water losses or cross-contamination. The elevated temperatures projected by RICCAR may lead to chemical and microbiological quality problems in potable water. Countries in the region suffer from high levels of non-revenue water, be it real or apparent losses, while the common practice of using septic tanks and cesspits in rural areas continues to limit the opportunities for wastewater reuse (LAS, ESCWA and ACWUA, 2016).

Migrants, whether seeking better economic conditions or fleeing environmental pressures or conflict, continue to pose a challenge to host countries. Especially since 2011, several countries have seen significant levels of migration, leading to increased challenges to the water supply and sanitation services, especially in urban areas where refugees have moved.

RICCAR outputs support the impact and vulnerability assessment of human settlements

Since human settlements are systems, climate change impacts occur at different physical scales and across a range of timescales, and the complex interactions within these systems must be carefully addressed.
to avoid conflicts between the objectives of adaptation, mitigation, economic growth and sustainable development. RICCAR provides various tools to assess such impacts, including for storm and sanitary drainage networks. For example, two extreme cases under the representative concentration pathways (RCP) scenarios 4.5 and 8.5 conclude that the maximum change of precipitation swings from an increase of 9.2 mm in 2035 (RCP4.5) to a drop of 10.9 mm in 2085 (RCP8.5).

Rising sea levels will flood coastal infrastructures and contribute to the deterioration of groundwater quality, such as along the coastline of Kuwait that stretches over 350 km. It is expected that a 2 m sea level rise in northern Kuwait alone would inundate up to $419 \text{ km}^2$, 97 per cent of which from the first 1 m sea level rise (Al-Ahmad, 2016).

**IWRM tools for identification of adaptation measures and options**

It is evident that traditional management methods for the Arab region’s water sector will no longer suffice. More meaningful involvement of civil society, particularly women, will be needed to develop new policies, avoid poor investments and generally ensure that development yields maximum social and economic returns (UN-Water, 2015).

An analysis of projected climate parameters and indices (ESCWA and LAS, 2015) predicts that the Arab region will witness a consistent warming trend but with more variable precipitation trends – drier conditions in the northern Maghreb – while extreme precipitation events will have strong spatial variability.

There are numerous best practices in climate change adaptation measures that countries in the Arab region can draw upon, such as water harvesting at ecosystem, watershed, urban and household levels, and which could narrow the gap between the 289 billion m$^3$ in total renewable water resources and the 1,724 billion m$^3$ of average rainfall. Several countries have already embarked on a water demand management, for example through the installation of water saving devices. Grey water reuse could help address the region’s acute water shortage, such as through individual treatment units reducing the loads on large treatment plants. A more conceptual adaptation measure is the water footprint assessment. It provides stakeholders with an understanding of the quantities and types of water required for specific products, and the resulting impact on water resources. Non-revenue water affects most of the Arab region, with both real and apparent losses that are proving detrimental to the financial viability of water utilities. However, this could be reduced through various approaches, such as sensors or strengthened governance. One adaptation measure with cross-sectoral implications is, for instance, to update urban planning policies to account for extreme precipitation events and build resilience.
Implementation of adaptation measures

Given the numerous possible adaptation measures and input from varied stakeholders, quantitative performance criteria will help assess alternative plans and policies, with particular consideration to institutional, social and economic contexts. Criteria can be grouped into technical feasibility, cost, social acceptance, adaptive capacity, indirect positive value, previous experience/capacity and technology transfer.

Decision support systems can be used to compare different interventions, tempered by the principle that no one method suits all circumstances of adaptation selection. Stakeholders should engage in participatory decision-making to analyse, screen and rank all criteria.

Areas for action: Suggestions for follow-up

Efforts should be made to promote the role of local authorities in forward planning and implementing adaptation measures, while recognizing that adaptation options may overlap multiple jurisdictions, thereby necessitating coordination among local authorities. Moreover, since human settlements typically represent dense and complex systems of interconnected services, adaptation measures should also address risk drivers to increase resilience.

At the national level, attention is needed to ensure that all stakeholders have a role in preparing an adaptation policy and sectoral and local adaptation action plans, as the basis for a comprehensive national response to the impacts of climate change.

Service providers in the Arab region need to be involved in assessing climate change impacts on utility services and infrastructure and their vulnerabilities, as adaptation plans push to avoid abandoning networks or undertaking costly retrofits. Furthermore, linkages and knock-on effects between different sectors must be an integral part of policymaking, in parallel to considering the interplay between the sectoral and local levels in decision-making.

ACWUA has been engaged in adaptation planning, policy discourse and more targeted research, such as developing diagnoses and strategies to reduce non-revenue water.
Climate Change Adaptation in Economic Development Using Integrated Water Resources Management Tools
Climate change impacts on economic development from a water perspective

Detailed computer-based modelling of economic assessments needs to be carried out to better take the results of regional climate modelling into account. The effects at regional and global scales can be categorized into three types: direct, indirect and deferred.

Expected direct impacts are related to the adverse effects of temperature increases and precipitation reduction and possible impacts, including market distortions, competition for resources among sectors, social instability and conflict, reduced growth, and the economic impacts of death and homelessness due to extreme events. One study (Dell and others, 2008) estimates that an increase of 1°C will lead to a drop in GDP of 1.1 per cent. Indirect impacts are mostly due to response measures undertaken either as part of adaptation measures outside the region or mitigation in industrialized countries.

The specificity of economic impacts varies from one country to another. The main impacts can be broadly grouped into five categories: drought and decreased precipitation; increases in temperature and in the frequency of heatwaves; increased frequency and intensity of extreme events; sea level rises; and local impact of changes in global weather patterns. In a region where around 40 per cent of the workforce is employed in agriculture, droughts and precipitation drops will be serious. The income of vulnerable population groups, such as rural non-farm households, will be particularly reduced. Sea level rises will exacerbate the effect of storm surges for the Gulf Cooperation Council countries, such as Kuwait where 65 per cent of the coastal GDP is at risk (Abdel-Gelil, 2009).

RICCAR outputs support the impact and vulnerability assessment of economic development

Regional climate models, such as those applied under RICCAR, form the basis of integrated assessment models (IAMs), and can inform detailed analysis of economic impacts due to climate change. The integrated vulnerability assessment developed under RICCAR can inform analysis in this regards. While
IAMs can describe how climate change impacts affect some economic sectors more than others (sectoral dimension) and evolve over the years (time dimension), RICCAR adds a spatial dimension by showing variations in climate change impacts and vulnerability across the region.

The vulnerability assessment methodology can be adapted to generate smaller-scale IAM outputs that can show the socio-economic implications of climate change at the country or local levels.

IWRM tools for identification of adaptation measures and options

Adaptation of socio-economic systems to climate change varies by type and technology. Many of the adaptation measures are reactive, occurring after the impacts of climate change become evident, for example raising insurance premiums or establishing disaster compensation. The other type of adaptation is anticipatory, taking place before impacts emerge and thus relying on increased awareness and forecasts. An example of the latter would be to develop incentives for implementing adaptation measures. On the technology front, soft technologies are based on technical knowledge and skills, while hard technologies are based on physical tools and equipment. Because of the unprecedented nature of climate change, adaptation planning should emphasize anticipatory actions while allowing flexibility to undertake reactive measures, when necessary.

As adaptation aims to limit negative effects on diverse socio-economic systems, it should address the economy’s exposure to climate change by minimizing any adverse costs that result from climatic changes. It should also address the economy’s sensitivity to climate change by minimizing the relative change in the adverse costs. IWRM allows for integrated frameworks to analyse water flows across sectors and spaces, and thus provides a bridge between the supply of water or sanitation services and wastewater management, and the socio-economic implications on agriculture, human health, coastal ecosystems and human settlements in a climate change context.

IWRM is an effective framework to achieve adaptation measures through strategies that consider both the demand and supply sides. Demand-side measures include improving water efficiency and economic incentives, while supply-side measures mostly involve targeted investments.

Implementation of adaptation measures

One of the approaches of implementing adaptation measures is climate proofing, which considers three levels of analysis: the local, the sectoral and the national level of policy planning. Such a methodology should address not only the challenges posed by climate change, but also opportunities
that may arise from it (GIZ, 2011; GIZ, 2012). Climate and hydrological models expose the biophysical impacts of climate change, while IAMs and vulnerability assessment determine their associated socio-economic costs.

The best practice for implementation is to develop an adaptation matrix through a staged multi-stakeholder process, which should start with a review of the driving forces of current developments to establish the key drivers of climate change. An evaluation of the drivers clarifies how they affect different regions and economic sectors. Boundary conditions should then be considered by testing the vision of the future against forecasts to put scenarios forward and to develop impact chains for each of the selected scenarios. In a next step, impacts and adaptation options are identified, reviewed and evaluated by drawing upon climate modelling efforts, such as RICCAR. Lastly, the prioritized adaptation options deemed crucial to enhance future adaptive capacity for each of the scenarios form an adaptation matrix, from which adaptation pathways can be pursued.

Areas for action: Suggestions for follow-up

Best practices provide policymakers with opportunities to learn from existing adaptation plans. Such practices require that implementation is managed by a permanent task force, that regular training leverages local knowledge, and that adaptation plans take climate change mitigation into account and are structured in such a way as to allow for matching grants or joint funding. Incorporating climate change assessments into national development strategies and action plans can help decision-makers to undertake informed investments in water-related infrastructures at the appropriate scale, and to pursue preventive measures that can reduce the risk of disasters to human health, ecosystems and livelihoods and lower the potential cost of climate change on sustainable development.
Additional Documentation

In addition to the introductory module, the following training materials are available for each module in electronic format.

Climate Change Adaptation and Ecosystem-Based Management Using Integrated Water Resources Management Tools

21 presentations related to the module contents
8 country case studies

Exercise 1: Ecosystem services
Exercise 2: Catchment ecosystem state and indicators
Exercise 3: Ecosystem services in management
Exercise 4: Ecosystem issue and indicators
Exercise 5: Trade-offs in ecosystem management
Exercise 6: Catchment stakeholder analysis
Exercise 7: Monitoring and evaluation
Exercise 8: Catchment incentives, tools and objectives
Exercise 9: The Maward dam

Climate Change Adaptation in Agriculture, Forestry and Fisheries Using Integrated Water Resources Management Tools

24 presentations related to the module contents
12 country case studies

Exercise 1: Dealing with sea level rise and seawater intrusion in a densely populated river delta
Exercise 2: How to manage horticultural production in a desert area with marginal water sources
Exercise 3: Optimizing agricultural water use in a semi-arid country
Exercise 4: Prioritising different adaptation measures based on screening criteria
Climate Change Adaptation in the Health Sector Using Integrated Water Resources Management Tools

25 presentations related to the module contents
11 country case studies

Exercise 1: Climate impacts on Water and public health and tracking climate readiness for a region/country
Exercise 2: Convening a methodological framework for the vulnerability assessment
Exercise 3: Distribution of roles and responsibilities in the health and water sectors
Exercise 4: Crisis management and long-term strategies within the health sector
Exercise 5: Moving from science to policy in Morocco

Climate Change Adaptation in Human Settlements Using Integrated Water Resources Management Tools

12 presentations related to the module contents
13 country case studies

Exercise 1: Za’atari refugee camp
Exercise 2: Mapping potential climate change impacts at the country level
Exercise 3: Assessing vulnerability
Exercise 4: Mapping potential climate change scenarios at the country level
Exercise 5: A simple planning example
Exercise 6: Simulation versus optimization
Exercise 7: Developing an artificial neural network for flow routing
Exercise 8: Assessing flood vulnerability using the group decision-making method
Exercise 9: Identifying lead departments and agencies for sectoral adaptation plans
Exercise 10: Selected SDG indicators
Climate Change Adaptation in Economic Development Using Integrated Water Resources Management Tools

21 presentations related to the module contents
9 country case studies

**Exercise 1:** Climate proofing for adaptation – scope and preparation
**Exercise 2:** Climate proofing for adaptation – analysis and assessment
**Exercise 3:** Climate proofing for adaptation – adaptation matrix

References


League of Arab States, Economic and Social Commission for Western Asia (ESCWA), and Arab Countries Water Utilities Association (ACWUA) (2015). The Regional Initiative for Establishing a Regional Mechanism for Improved Monitoring and Reporting on Access to Water Supply and Sanitation Services in the


Partner websites

http://www.unep.org/rowa
https://www.giz.de/en/
http://www.who.int/en/
http://www.emro.who.int/entity/ceha/index.html
https://acwua.org
https://www.unescwa.org

Source: Ihab Jnad, ACSAD.
ENVIRONMENT
Climate Change Adaptation and Ecosystem-Based Management Using Integrated Water Resources Management Tools

AGRICULTURE
Climate Change Adaptation in Agriculture, Forestry and Fisheries Using Integrated Water Resources Management Tools

HEALTH
Climate Change Adaptation in the Health Sector Using Integrated Water Resources Management Tools

HUMAN SETTLEMENTS
Climate Change Adaptation in Human Settlements Using Integrated Water Resources Management Tools

ECONOMIC DEVELOPMENT
Climate Change Adaptation in Economic Development Using Integrated Water Resources Management Tools